Winter Aerosol Composition and Evolution Experiment (WACEE)

(Daum, Lee, Kleinman, Wang, Springston, McGraw, Fast)

Focus- Understanding of the processes associated with the formation and growth, and composition of aerosol particles, with a particular emphasis on the processes that lead to the formation secondary organic aerosol (SOA).

Seasonal differences Likely to be Important

1. *Photochemistry*- Lower solar intensity and reduced absolute humidity will greatly reduce OH in winter relative to summer slowing down all photochemically driven processes including those involving O_3 and H_2O_2.
2. *Thermodynamics*- Distribution of semi-volatile substances (organics, nitrates…) will be enhanced during winter because of the lower temperatures.
3. *Precursors*- Seasonal differences in emissions, particularly biogenic emissions, should lead to seasonal differences in aerosol composition that may be useful in assessing the importance of these compounds in determining aerosol composition.

Scientific Questions

Scientific issues to be addressed include:

- Summer/winter differences in POA emissions of representative anthropogenic and biogenic sources.
- Relationship between POA and black carbon in urban emissions
- Processing of POA in relation to photochemistry, summer vs winter
- Formation of SOA in urban and power plant plumes in relation to photochemistry
- Formation of SOA from biogenic emissions with and without urban and power plant influences
- Hygroscopicity, light scattering and absorption coefficients, and CCN properties of aerosols as a function of sources, atmospheric age, and season.

Scientific Questions, cont'd

•Growth mechanism for SOA (i.e., condensation or Pankow-Seinfeld volume growth) as a function of processing conditions including summer/winter differences.

•Evolution of aerosol specific absorption as the aerosol ages.

•Winter/summer differences in aerosol precursors particularly biogenic precursors and their influence on aerosol composition.

•Whether current aerosol models can capture the seasonal differences in aerosol composition, particularly SOA.

Desired Experimental Conditions

- Location where aerosol processes have been studied in summer.
- Significant isolated urban source at a location that can be easily sampled by aircraft.
- Presence of isolated SO_2 point sources such as power plants.
- In a region with strong seasonal differences in the emissions of biogenic aerosol precursors.

Potential Locations

- NE US- Region extensively studied by NOAA and others during the 2004 ICART Study.
- Nashville, TN- Region extensively studied by NOAA, BNL, in 1995 & 1999.

Advantages of Nashville

•Nashville is a fairly isolated urban area whose emissions as well as regional background can be well identified, tracked, and characterized.

•The city is located in the forested southeast US where biogenic hydrocarbon emissions, both isoprene and monoterpenes, are highly important

•There are at least four major power plants near the city, one located at the edge of the metropolitan area, the other three located ~100 km to the north and west.

Advantages of a NE US Study

- Region well characterized during a major study in 2004.

- SOA formation data and analysis available for comparison to winter-time data.

- Transport over the N. Atlantic allows for the possibility of aerosol evolution studies under simplified conditions.

Biomass Burn Study

Rationale- Globally, ~40% of emissions of aerosols and aerosol precursors come from biomass burning.

Forest fires
Agriculture (land clearing, crop residues, harvesting practices)
Domestic use (cooking, heat, etc)

Extensive studies have been conducted to understand emissions, and aerosol optical properties, but little known about the identity and rates of the processes responsible for the evolution of these aerosols as they age and become dispersed. ASP in a good position to address these issues.

Studies in the Developing world

- Major sources of aerosols and aerosol precursors
    - Biomass burning
    - Electrical power generation
    - Vehicle emissions
- Potentially large climate effects
    - Alteration of precipitation patterns
    - Alteration of atmospheric heating rate profiles
- Aerosol properties and processes not well characterized

    Major studies have been conducted, but much remains to be learned regarding- aerosol properties and the processes responsible for their evolution; transport and distribution of aerosols and their effects on cloud radiative properties, lifetime, and precipitation patterns.